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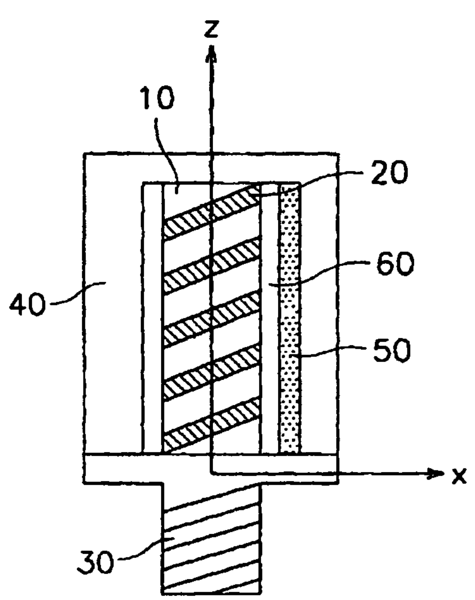
(54) Title: ELECTROMAGNETIC RADIATION BLOCKING ANTENNA AND FABRICATION METHOD THEREOF




(57) Abstract: Disclosed is an antenna having an electromagnetic radiation blocking function and a fabrication method thereof. A helical line is formed by winding a copper wire on a helical groove formed on a core, or using a spring instead of the core, or printing a metal paste in a helical form on the core. A shielding layer for blocking the electromagnetic radiation is provided on a part of the circumferential surface of the helical antenna thus obtained, i.e., on a side of the core in a direction towards a user (in the x direction). The shielding layer comprises a metal material with high electrical conductivity or an electromagnetic radiation absorbing material. Furthermore, the metal paste is printed only on one side of the core to form an antenna so as to reduce the amount of electromagnetic radiation on the other side of the core not printed with the metal paste. Also, a conductive material is attached on one side of the antenna and electrically connected to the end of the helical line to induce a large amount of electromagnetic radiation in a direction towards the conductive material, thus decreasing the electromagnetic radiation in a direction opposite to the conductive material. Consequently, the electromagnetic radiation is reduced in a direction towards the user in a near field to the antenna but uniformly emitted in all directions in a far field from the antenna so that the harmful effects of the electromagnetic radiation on the user can be reduced without deteriorating the performance of the antenna.

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# Electromagnetic Radiation Blocking Antenna and Fabrication Method Thereof

## BACKGROUND OF THE INVENTION

### (a) Field of the Invention

The present invention relates to an antenna having an electromagnetic radiation blocking function and a fabrication method thereof. More specifically, the present invention relates to an antenna capable of shielding the user of a mobile telecommunication terminal against electromagnetic radiation emitted from a helical antenna used in the mobile telecommunication terminal, and a fabrication method thereof.

### (b) Description of the Related Art

Helical antennas, which are widely used in mobile telecommunication terminals, include a long copper wire $\lambda/4$ in length that is wound around a core formed from an insulating material to a reduced volume. The performance of helical antennas has a great influence on that of mobile telecommunication terminals.

Now, a description will be given as to the conventional helical antenna with reference to the accompanying drawings.

FIG. 1 is a schematic diagram illustrating the structure of a conventional helical antenna used in a mobile communication terminal.

As shown in FIG. 1a, the conventional helical antenna has a plastic core 1 formed from an insulating material and provided with a groove that is of a helical form, and a copper wire 2 wound on the groove in the helical form. The outer surface of the core 1 wound with the copper wire 2 is sealed with a plastic resin.

Contrarily, as shown in FIG. 1b, the helical antenna can be formed using a helical spring 4 instead of the core. In this case, the elasticity of the spring itself incurs deformation and makes it impossible to perform surface molding. For that reason, the spring 4 has to be sealed and protected with a

resin-based cover 5 to complete the helical antenna.

Generally, the performance of the terminal, namely, speech sensitivity depends on that of the antenna. Thus the conventional helical antenna for terminals with such a structure must have an omni-directional radiation characteristic in order to provide high speech sensitivity in all directions.

FIGS. 2a and 2b show the radiation characteristics of the conventional helical antenna.

FIG. 2a shows the radiation characteristic in a region adjacent to the antenna, i.e., in a near field, and FIG. 2b shows the radiation characteristic in a region apart from the antenna, i.e., in a far field.

When viewed from the axial direction (z axis) of the antenna, the circular radiation characteristic allows uniform radiation in all directions as shown in FIGS. 2a and 2b.

Assuming that the user stands in the x direction from the antenna, the amount of electromagnetic radiation emitted from the antenna for terminals is the same towards the user (in the x direction) and opposite to the user (in the -x direction).

Due to this omni-directional radiation characteristic of the antenna, the user is exposed to and adversely absorbs the harmful electromagnetic radiation.

Decreasing the amount of radiation from the antenna in order to reduce the effect on the user, however, leads to a deterioration of the performance of the antenna, i.e., speech quality.

## SUMMARY OF THE INVENTION

It is an object of the present invention to reduce the exposure of electromagnetic radiation to a user without deteriorating the performance of an antenna.

To achieve the above object, an electromagnetic radiation blocking material is attached on one side of a helical antenna according to the present

invention, i.e., on the surface towards the user, to reduce the exposure of the electromagnetic radiation to the user.

In one aspect of the present invention, an antenna having an electromagnetic radiation blocking function includes: a core comprising an insulating material; a conductive line formed on one side of the core in a direction opposite to a user; and a power feed section connected to the conductive line, formed on the lower side of the core and electrically connected to an exterior circuitry.

The antenna may further include at least one shielding layer formed on the other side of the core in a direction towards the user for shielding the user from the electromagnetic radiation.

In another aspect of the present invention, an antenna having an electromagnetic radiation blocking function includes: a core comprising an insulating material; a conductive line formed in a helical form on the whole surface of the core; at least one shielding layer formed on one side of the core in a direction towards a user for shielding the user from the electromagnetic radiation; and a power feed section connected to the conductive line, formed on the lower side of the core and electrically connected to an exterior circuitry.

The shielding layer comprises a metal material for reflecting the electromagnetic radiation to shield the user from the electromagnetic radiation. The antenna further includes an insulating layer formed between the core and the shielding layer.

On the other hand, the shielding layer comprises an electromagnetic radiation absorbing material for absorbing the electromagnetic radiation emitted towards the user to shield the user from the electromagnetic radiation. Examples of the electromagnetic radiation absorbing material include a single radio wave absorber selected from the group consisting of ferrite, $BaTiO_3$, NiO and CuO, or a composite ferrite obtained by mixing ferrite with rubber.

The shielding layer extends towards the upper side of the core so as

to more effectively shield the user from the electromagnetic radiation.

The conductive line formed on the core comprises a conductive and viscous paste, or a metal wire.

In another aspect of the present invention, a method for fabricating an antenna having an electromagnetic radiation blocking function includes the steps of: forming a conductive line in a helical form on the surface of a core comprising an insulating material; forming at least one shielding layer on one side of the core in a direction towards a user for shielding the user from the electromagnetic radiation; disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and sealing the outer surface of the core with a cover comprising an insulating material.

In still another aspect of the present invention, a method for fabricating an antenna having an electromagnetic radiation blocking function includes the steps of: forming a conductive line in a helical form on one side of a core in a direction opposite to a user, the core comprising an insulating material; disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and sealing the outer surface of the core with a cover comprising an insulating material.

In still another aspect of the present invention, a method for fabricating an antenna having an electromagnetic radiation blocking function includes the steps of: forming a conductive line on one side of a core in a direction opposite to a user, the core comprising an insulating material; forming a conductive member connected to the upper side of the conductive line and attaching the conductive member on the one side of the core in the direction opposite to the user; disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and sealing the outer surface of the core with a cover comprising an insulating material.

The method may further include the step of forming at least one

shielding layer on the other side of the core without the conductive member attached thereon, for shielding the user from the electromagnetic radiation.

In this case, a large amount of the electromagnetic radiation is induced in a direction towards the conductive material so as to reduce the electromagnetic radiation in a direction opposite to the conductive material.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention, and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a cross-sectional view showing the structure of a conventional antenna used in a mobile telecommunication terminal;

FIGS. 2a and 2b are diagrams showing the radiation characteristics of the conventional antenna;

FIG. 3a is a cross-sectional view of an antenna having an electromagnetic radiation blocking function in accordance with a first embodiment of the present invention;

FIG. 3b is a plan view of the antenna shown in FIG. 3a;

FIG. 4a is a cross-sectional view of an antenna having an electromagnetic radiation blocking function in accordance with a second embodiment of the present invention;

FIG. 4b is a plan view of the antenna shown in FIG. 4a;

FIGS. 5a and 5b are schematic views showing the structure of an antenna having an electromagnetic radiation blocking function in accordance with a third embodiment of the present invention;

FIGS. 6a and 6b are cross-sectional views of an antenna having an electromagnetic radiation blocking function in accordance with a fourth embodiment of the present invention;

FIG. 7 is a schematic diagram of an apparatus for fabricating the antenna shown in FIGS. 6a and 6b;

FIGS. 8a and 8b are cross-sectional views of an antenna having an electromagnetic radiation blocking function in accordance with a fifth embodiment of the present invention;

FIGS. 9a and 9b are cross-sectional views of an antenna having an electromagnetic radiation blocking function in accordance with a sixth embodiment of the present invention;

FIG. 10 is an external perspective view of a terminal equipped with the antenna according to the embodiments of the present invention; and

FIGS. 11a and 11b are diagrams showing the radiation characteristics of the antenna according to the embodiments of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following detailed description, only the preferred embodiment of the invention has been shown and described, simply by way of illustration of the best mode contemplated by the inventor(s) of carrying out the invention. As will be realized, the invention is capable of modification in various obvious respects, all without departing from the invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not restrictive.

FIG. 3a is a cross-sectional view of an antenna having an electromagnetic radiation blocking function in accordance with a first embodiment of the present invention, and FIG. 3b is a plan view of the antenna shown in FIG. 3a.

As shown in FIGS. 3a and 3b, the helical antenna according to the first embodiment of the present invention has a plastic core 10 formed from an insulating material and provided with a groove that is of a helical form, and a copper wire 20 wound on the groove in a helical form. On the lower side of the plastic core 10 is formed a conductive power feed section 30 electrically connected to an exterior circuitry. The outer surface of the core 10 on which the copper wire 20 is wound is sealed with a plastic resin 40.

Between the core 10 and the plastic resin 40 is formed a shielding layer 50 for blocking the electromagnetic radiation. The shielding layer 50 does not wrap the whole surface of the circular core 10 but just part of the outer surface of the circular core 10. In particular, the shielding layer 50 according to the present invention is, as shown in FIGS. 3a and 3b, formed on the core 10 in a direction towards the user (in the x direction). The angle of the shielding layer 50 formed on the outer surface of the core 10 determines the degree of blocking of the electromagnetic radiation exposed to the user.

The shielding layer 50 is composed of a metal material that reflects the electromagnetic radiation and shields the user from the electromagnetic radiation. Between the core 10 and the shielding layer 50 is formed an insulator in order to prevent an electrical contact between the shielding layer 50 and the copper wire 20 wound around the core 10. This embodiment of the present invention has an insulating tube 60 as shown in FIGS. 3a and 3b.

Now, a description will be given as to a method for fabricating the helical antenna with such a structure in accordance with the first embodiment of the present invention.

First, the helical groove is formed on the outer surface of the core 10 and the copper wire 20 is wound on the groove to form a helical line, after which the entire outer surface of the core 10 is wrapped with the tube 60 that is formed from an insulating polymer. In regard to this, the tube 60 can wrap only a part of the outer surface of the core 10 depending on the installation of the shielding layer 50.

Subsequently, the shielding layer 50 is provided on a part of the circumference of the tube 60, i.e., on the surface of the tube 60 in a direction towards the user (in the x direction).

The shielding layer 50 is preferably composed of a metal material with high electrical conductivity such as copper, silver, etc. The shielding layer 50 is fabricated in the form of an adhesive tape attached to the tube 60, or a thin sheet fabricated by the tape-casting method and attached to the

tube 60. Alternatively, the shielding layer 50 can be formed by coating a metal material on the surface of the tube 60 in a direction towards the user to form the shielding layer 50 or by casting a metal material into a sheet of an appropriate size.

Following installation of the shielding layer 50 on the one side of the tube 60, the power feed section 30 that is a fixed metal rod for power supply is attached on the lower side of the core 10 and the plastic resin 40 is injection molded on the outer surface of the tube 60, thus completing a helical antenna.

As such, the shielding layer 50 is formed on the core 10 in a direction towards the user so as to reflect the electromagnetic radiation emitted from the core 10 and shield the user from the electromagnetic radiation.

Because the degree of blocking of the electromagnetic radiation depends on the angle of the shielding layer 50 formed on the outer surface of the core 10, the angle of the shielding layer 50 on the outer surface of the core 10 can be adjusted according to a required blocking effect against the electromagnetic radiation.

For example, the shielding layer 50 can be formed at about 180 ° so as to wrap about half the outer surface of the core 10 in a direction towards the user (in the x direction), or at about 270 ° to wrap about 3/4 of the outer surface of the core 10, or at about 90 ° to wrap about 1/4 of the outer surface of the core 10. The amount of the electromagnetic radiation shielded from the user increases with an increase in the angle of the shielding layer 50 formed on the outer surface of the core 10.

The angle of the shielding layer 50, i.e., the area of the shielding layer 50 formed on the outer surface of the core 10 can be regulated in consideration of the blocking or absorbing characteristic of the shielding layer 50 as long as it does not deteriorate the characteristic of the antenna.

Now, a description will be given as to an antenna having an electromagnetic radiation blocking function in accordance with a second embodiment of the present invention.

FIG. 4a is a cross-sectional view of the antenna having an electromagnetic radiation blocking function in accordance with the second embodiment of the present invention, and FIG. 4b is a plan view of the antenna shown in FIG. 4a.

As shown in FIGS. 4a and 4b, the helical antenna according to the second embodiment of the present invention has the same structure as described in regard to the first embodiment, excepting that a shielding layer 51 is composed of material that absorbs the electromagnetic radiation and shields the user from the exposure of the electromagnetic radiation.

Unlike the first embodiment, no insulating tube is separately provided between a core 10 and the shielding layer 51 because the shielding layer 51 has an insulating property.

In fabrication of the antenna according to the second embodiment of the present invention, a copper wire 20 is wound around the core 10 in a helical form and the shielding layer 51 is provided on a part of the circumference of the core 10, i.e., on the circumferential surface of the core 10 in a direction towards the user.

In the second embodiment of the present invention, the material for the shielding layer 51 is a single radio wave absorber such as ferrite, $BaTiO_3$, NiO, CuO, etc., or a composite ferrite obtained by mixing ferrite with rubber when it needs to absorb a high frequency, in the level of GHz. Even when using such an electromagnetic radiation absorber, the shielding layer 51 can be fabricated in various ways as described above, including tape casting, coating, casting, or the like.

The shielding layer 51 formed on the core 10 in a direction towards the user absorbs the electromagnetic radiation emitted from the core 10 and shields the user from the electromagnetic radiation. In the second embodiment of the present invention, the degree of blocking of the electromagnetic radiation can be controlled by regulating the angle of the shielding layer 51 formed on the outer surface of the core 10 as described in the first embodiment.

Now, a description will be given as to a third embodiment of the present invention with an enhanced electromagnetic radiation blocking effect.

FIG. 5a is a cross-sectional view showing the structure of an antenna having an electromagnetic radiation blocking function in accordance with the third embodiment of the present invention, and FIG. 5b is a plan view of the antenna according to another example of the third embodiment.

To enhance the electromagnetic radiation blocking effect, the antenna that has the same structure as described in the first embodiment includes a shielding layer 52 not only formed on the one side of the core 10 in a direction towards the user but also extending to the upper side of the core 10, as shown in FIG. 5a.

In this case, the shielding layer 52 blocks the electromagnetic radiation from the upper side of the core 10 (in the y direction) as well as the part of the core 10 in a direction towards the user (in the x direction), thus effectively shielding the user from the electromagnetic radiation.

Alternatively, more than one shielding layer can be provided as shown in FIG. 5b.

As shown in FIG. 5b, between the core 10 and the plastic resin 40 is sequentially formed a first shielding layer 53 and a second shielding layer 54 to effectively block the electromagnetic radiation from the user (in the x direction). Although the first shielding layer 53 is composed of an electromagnetic radiation absorber, the first and second shielding layers 53 and 54 can be selectively composed of an electromagnetic radiation reflecting material or an electromagnetic radiation absorbing material.

For example, both the first and second shielding layers 53 and 54 can be made from an electromagnetic radiation reflecting material or an electromagnetic radiation absorbing material. Alternatively, the first shielding layer 53 is made from an electromagnetic radiation reflecting material and the second shielding layer 54 is an electromagnetic radiation absorbing material; or the first shielding layer 53 is made from an electromagnetic radiation absorbing material and the second shielding layer 54 is an

electromagnetic radiation reflecting material.

In a case where the first shielding layer 53 provided on the one side of the core 10 is composed of an electromagnetic radiation reflecting material, a separate insulator is preferably provided between the core 10 and the first shielding layer 53 as in the first embodiment.

Now, a description will be given as to a fourth embodiment of the present invention, which refers to a fabrication of the antenna having an electromagnetic radiation blocking function with a conductive line formed only on the one side of the core instead of a helical line on the whole surface of the core, unlike the above-described first to third embodiments.

FIGS. 6a and 6b are perspective views of an antenna having an electromagnetic radiation blocking function in accordance with the fourth embodiment of the present invention.

As shown in FIGS. 6a and 6b, the antenna according to the fourth embodiment of the present invention has a conductive line 21 formed not on the whole surface of the core 10 but on the one side of the core 10. That is, unlike the first to third embodiments in which the helical line is formed along the circumferential surface of the core 10, the conductive line 21 is formed in various forms only on the one side of the core 10 in a direction opposite to the user (in the -x direction).

To fabricate the antenna according to the fourth embodiment of the present invention, a separate apparatus is required as illustrated in FIG. 7.

As shown in FIG. 7, the apparatus for fabricating the antenna according to the fourth embodiment of the present invention comprises: a core driver 100 for rotating the core 10, a paste feeder 200 for feeding a conductive paste, a roller 300 for printing the conductive paste on the surface of the core 10, a roller driver 400 for rotating the roller 300, and a controller 500 for controlling the core driver 100 and the roller driver 400.

The paste feeder 200 comprises a paste box 210 containing a paste, and a paste inlet 220 for injecting the paste into the paste box 210. The paste is formed from a conductive and viscous material.

The roller 300 comprises two rollers 310 and 320 for appropriately regulating the amount of the paste to be printed on the core 10. The first roller 310 is positioned in contact with the paste in the paste box 210. The second roller 320 is disposed on the first roller 310 so as to contact the core 10 when it contacts the first roller 310. The number of rollers is not limited to two, and more than two rollers can be used.

The roller driver 400 rotates the roller 300 under the control of the controller 500, and in the fourth embodiment of the present invention, comprises a first roller driver 410 for rotating the first roller 310 and a second roller driver 420 for rotating the second roller 320. The core driver 100 and the first and second roller drivers 410 and 420 are all comprised of motors.

Now, a description will be given as to a method for fabricating the antenna according to the fourth embodiment of the present invention using the fabrication apparatus as described above.

As the core 10 is positioned at a printing position and the paste is fed into the paste box 210, the controller 500 drives the core driver 100 and the roller driver 400 based on a plurality of control values for driving the rollers 310 and 320, namely, the rotational speed of the core 10 and the roller 300 determined by the diameters of the core 10 and the roller 300, the moving speed determined by the operational frequency band of the antenna, and the degree of rotation of the core 10 and the roller 300. The controller 500 also drives the core driver 100 according to the moving speed of the core 10 determined by the operational frequency band of the antenna.

As the first and second roller drivers 410 and 420 and the core driver 100 rotate under the control of the controller 500, the first and second rollers 310 and 320 and the core 10 are correspondingly rotated, respectively. Meanwhile, the core 10 is rotated by the core driver 100 and moves in a direction of the arrow at a preset moving speed. The first and second rollers 310 and 320 are rotated in directions opposite to each other and the core 10 is rotated in a direction opposite to the second roller 320.

As the first roller 310 rotates, the paste contained in the paste box

210 is applied to and moved on the surface of the first roller 310. Upon ascending to a predetermined position on the surface of the first roller 310, the paste is applied to and moved on the surface of the second roller 320, which is rotating in contact with the first roller 310 and in a direction opposite to the first roller 310.

Upon ascending to a predetermined position on the surface of the second roller 320, the paste begins to be printed on the surface of the core 10 that is rotating in contact with the second roller 320. In this regard, the core 10 rotates by about 180 ° not 360 ° and moves in the horizontal direction as shown in FIG. 7 in order to form the conductive line only on the one side of the core 10 in a direction opposite to the user, not on the whole surface of the core 10. As a result, the paste is printed to form the conductive line 21 only on the one surface of the core 10.

The width of the conductive line 21 varies depending on the rotational speeds of the core 10 and the second roller 320 and the pitch distance of the conductive line 21 depends on the moving speed of the core 10.

The antenna fabricated by the apparatus as shown in FIG. 7 in which the conductive line 21 is formed only on the one side of the core 10 allows it to shield the user from the electromagnetic radiation emitted from the core 10 in a direction towards the user (in the x direction) from the core 10 without using a separate shielding layer.

The form of the conductive line 21 provided only on the one side of the core 10 in the present invention is not limited to the illustration and may include any other geometrical form possible.

Contrary to the above-described embodiments, the helical line can be formed on the core by means of a dispenser instead of the roller. For example, the outlet of the dispenser that contains the conductive and viscous paste is positioned in contact with the surface of the core and the inner pressure of the dispenser is controlled, while the core is rotating and moving, to discharge the paste from the dispenser and form a helical line on the

surface of the core.

Other various techniques can be used to print a helical line of the surface of the core.

Now, a description will be given as to an antenna having an electromagnetic radiation blocking function in accordance with a fifth embodiment of the present invention.

FIGS. 8a and 8b are cross-sectional views of the antenna according to the fifth embodiment of the present invention.

Referring to FIGS. 8a and 8b, the antenna according to the fifth embodiment of the present invention has a conductive line 21 formed only on one side of the core 10 (in a direction opposite to the user) in order to enhance the electromagnetic radiation blocking performance of the antenna, and a shielding layer 50 formed on the other side of the core 10 (in a direction towards the user) without using the conductive line 21 as described in the first to third embodiments.

The shielding layer 50 can be composed of both an electromagnetic radiation reflecting material and an electromagnetic radiation absorbing material as described in the first and second embodiments.

As such, the antenna has a shielding layer in a direction towards the user and a conductive line in a direction opposite to the user so as to effectively shield the user from the electromagnetic radiation.

The antenna of the present invention is not limited to the above-described embodiments and may be applicable to all antennas available.

Now, a description will be given as to an antenna having an electromagnetic radiation blocking function in accordance with the sixth embodiment of the present invention.

FIGS. 9a and 9b are cross-sectional views of an antenna having an electromagnetic radiation blocking function in accordance with the sixth embodiment of the present invention. As shown in FIGS. 9a and 9b, the antenna has a copper wire 20 formed in a helical form on the surface of a core 10, and a conductive member 70 extending from the copper wire 20 to

the upper side of the core 10 at which the copper wire 20 ends. The conductive member 70 is attached on the one side of the core 10 in a direction opposite to the user (in the –x direction) and electrically connected to the copper wire 20.

The conductive member 70 may be integrally formed with or separately formed from the copper wire 20. The conductive member 70 may be not only in the form of a line but also in the form of a sheet having a given width.

Between the core 10 and the conductive member 70 is formed an insulating tube 60 as described in the first embodiment.

In a case where the conductive member 70 connected to the copper wire 20, i.e. the helical line is formed downward, the electromagnetic radiation concentrates on the side of the conductive member extending to the helical line and thus decreases in a direction towards the user, i.e., in the x direction.

The antenna according to the sixth embodiment of the present invention as illustrated in FIG. 9 may have an electromagnetic radiation blocking material attached to the side of the antenna in the x direction as described in the first embodiment in order to enhance the electromagnetic radiation blocking effect.

When the conductive line is formed only on the one side of the core as shown in FIGS. 6a, 6b or 8, the conductive member extending from the conductive line can be formed as described in the sixth embodiment and attached in a direction opposite to the user (in the –x direction). Such a composite method maximizes the blocking effect of the electromagnetic radiation irradiated on the user.

FIG. 10 is an outer perspective view of a terminal equipped with the antenna as fabricated above.

As shown in FIG. 10, the portion with the shielding layer made from an electromagnetic radiation blocking material is positioned in a direction towards the user (in the x direction), or the conductive material is connected

to the antenna and attached on the one side of the antenna of which the side destitute of the conductive material is positioned in a direction towards the user (in the x direction), thus remarkably reducing the specific absorption rate (SAR) of the user.

The antenna according to the embodiments of the present invention is installed in the terminal as illustrated in FIG. 10 to obtain radiation characteristics as shown in FIGS. 11a and 11b. More specifically, FIG. 11a shows the radiation characteristic in a near field and FIG. 11b shows the radiation characteristic in a far field.

Generally, the electromagnetic radiation has a higher radiation power value within a shorter distance from the source. So, the influence of the electromagnetic radiation on the user is significant only when the antenna of the terminal is present in an area adjacent to the user, i.e., in a near field.

In a far field where the terminal is far from the user, the influence of electromagnetic radiation on the user is negligible but the electromagnetic radiation directly affects the performance (sensitivity) of the antenna. Thus the amount of the radiation needs not deteriorate in any direction in the far field.

Referring to the radiation characteristic of the antenna according to the embodiments of the present invention in a near field, as shown in FIG. 11a, there is no change in the radiation in a direction opposite to the user (in the -x direction) but the radiation is reduced in a direction towards the user (in the x direction), thus reducing the influence of the electromagnetic radiation on the user.

Referring now to the radiation characteristic of the antenna in a far field where the terminal is far from the user, as shown in FIG. 11b, the radiation characteristic is uniform regardless of the direction.

Such a characteristic of the antenna according to the embodiments of the present invention can be explained by the Huygen's Principle.

According to the Huygen's Principle, the propagation of the electromagnetic radiation occurs due to an overlap of the individual waves so

that the electromagnetic radiation can be blocked by the electromagnetic radiation blocking or absorbing material in the near field but emitted even from the portion with the electromagnetic radiation blocking material attached thereto because of the overlap of the waves irradiated from the non-shielded portion in the far field.

The embodiments of the present invention reduce the electromagnetic radiation in the x direction in a near field but show no change in the electromagnetic radiation in a far field, which achieves the optimized condition to reduce the harmful effect of the electromagnetic radiation on the user without deteriorating the characteristic of the antenna.

While this invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

As described above, according to the present invention, the electromagnetic radiation is blocked from the user in a near field where the antenna is near the user, thus remarkably decreasing the effect of the electromagnetic radiation on the user.

Furthermore, the present invention maintains the radiation characteristic in the far field, which is related to the characteristic of the antenna, as the conventional antenna without deteriorating the characteristic of the antenna by using a method of attaching an electromagnetic radiation blocking material on a part of the antenna in a direction towards the user, or connecting a conductive material to the antenna and attaching the conductive material to the one side of the antenna to induce the electromagnetic radiation to one direction.

**WHAT IS CLAIMED IS:**

1. An antenna having an electromagnetic radiation blocking function comprising:

a core comprising an insulating material;

a conductive line formed on one side of the core in a direction opposite to a user; and

a power feed section connected to the conductive line, formed on the lower side of the core and electrically connected to an exterior circuitry.

2. The antenna as claimed in claim 1, further comprising at least one shielding layer formed on the other side of the core in a direction towards the user for shielding the user from the electromagnetic radiation.

3. An antenna having an electromagnetic radiation blocking function comprising:

a core comprising an insulating material;

a conductive line formed in a helical form on the whole surface of the core;

at least one shielding layer formed on one side of the core in a direction towards a user for shielding the user from the electromagnetic radiation; and

a power feed section connected to the conductive line, formed on the lower side of the core and electrically connected to an exterior circuitry.

4. The antenna as claimed in claim 2 or 3, wherein the shielding layer comprises a metal material for reflecting the electromagnetic radiation to shield the user from the electromagnetic radiation.

5. The antenna as claimed in claim 4, further comprising an insulating layer formed between the core and the shielding layer.

6. The antenna as claimed in claim 2 or 3, wherein the shielding layer comprises an electromagnetic radiation absorbing material for absorbing the electromagnetic radiation emitted towards the user to shield the user from the electromagnetic radiation.

7. The antenna as claimed in claim 6, wherein the shielding layer

comprises a single radio wave absorber selected from the group consisting of ferrite, $BaTiO_3$, NiO and CuO, or a composite ferrite obtained by mixing ferrite with rubber.

8. The antenna as claimed in claim 2 or 3, wherein the shielding layer extends towards the upper side of the core.

9. The antenna as claimed in claim 2 or 3, wherein the conductive line formed on the core comprises a conductive and viscous paste.

10. The antenna as claimed in claim 2 or 3, wherein the conductive line formed on the core comprises a metal wire.

11. A method for fabricating an antenna having an electromagnetic radiation blocking function, comprising the steps of:

forming a conductive line in a helical form on the surface of a core comprised of an insulating material;

forming at least one shielding layer on one side of the core in a direction towards a user for shielding the user from the electromagnetic radiation;

disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and

sealing the outer surface of the core with a cover comprising an insulating material.

12. A method for fabricating an antenna having an electromagnetic radiation blocking function, comprising the steps of:

forming a conductive line in a helical form on one side of a core in a direction opposite to a user, the core comprising an insulating material;

disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and

sealing the outer surface of the core with a cover comprising an insulating material.

13. The method as claimed in claim 12, further comprising the step

of forming at least one shielding layer on the other side of the core without the conductive line formed thereon, for shielding the user from the electromagnetic radiation.

14. A method for fabricating an antenna having an electromagnetic radiation blocking function, comprising the steps of:

forming a conductive line in a helical form on the surface of a core comprising an insulating material;

forming a conductive member connected to the upper side of the conductive line and attaching the conductive member on one side of the core in a direction opposite to a user;

disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and

sealing the outer surface of the core with a cover comprising an insulating material.

15. A method for fabricating an antenna having an electromagnetic radiation blocking function, comprising the steps of:

forming a conductive line on one side of a core in a direction opposite to a user, the core comprising an insulating material;

forming a conductive member connected to the upper side of the conductive line and attaching the conductive member on the one side of the core in a direction opposite to the user;

disposing a power feed section connected to the conductive line and electrically connected to an exterior circuitry on the lower side of the core; and

sealing the outer surface of the core with a cover comprising an insulating material.

16. The method as claimed in claim 14 or 15, further comprising the step of forming at least one shielding layer on the other side of the core without the conductive member attached thereon, for shielding the user from the electromagnetic radiation.

FIG.1A

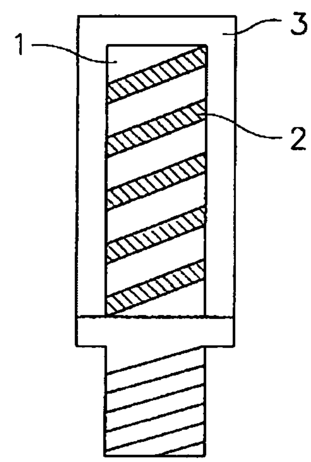



FIG.1B

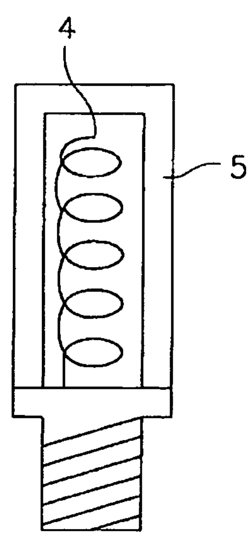
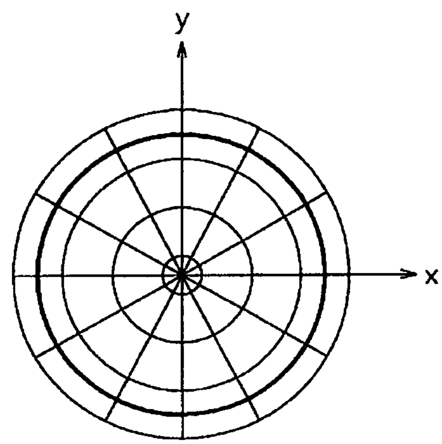
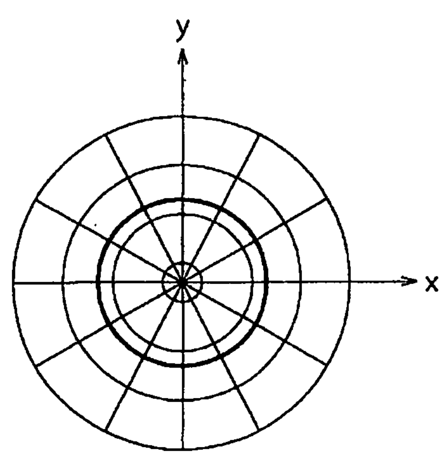


FIG.2A




radiation characteristic in near field

FIG.2B




radiation characteristic in far field

FIG.3A

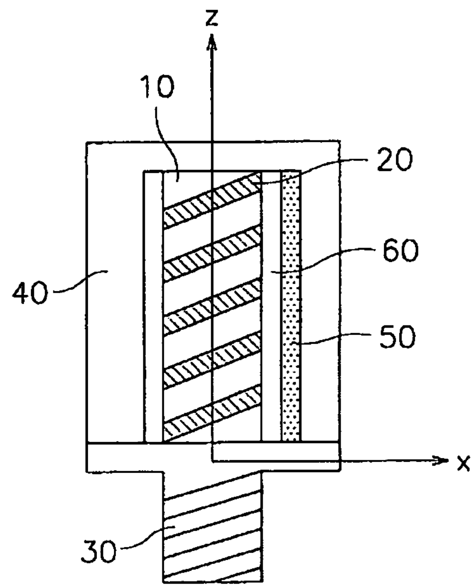



FIG.3B

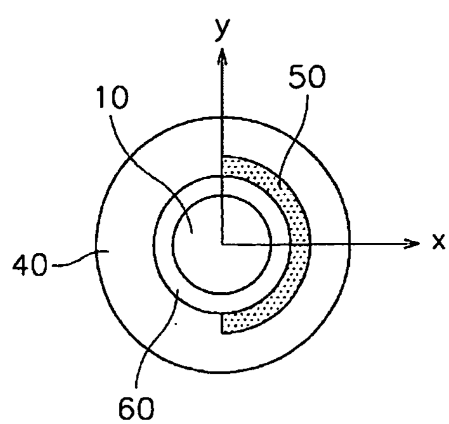


FIG.4A

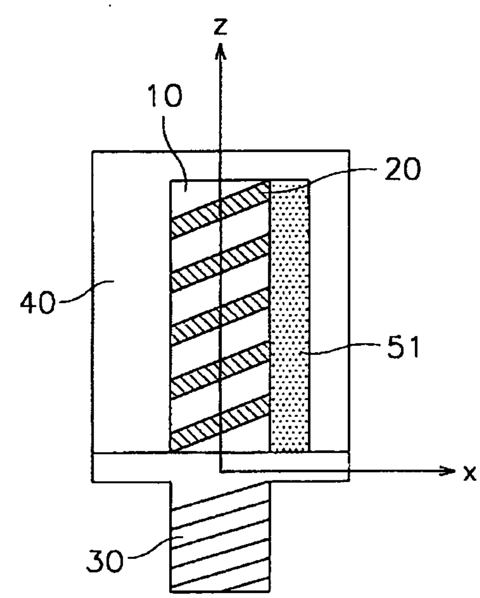



FIG.4B

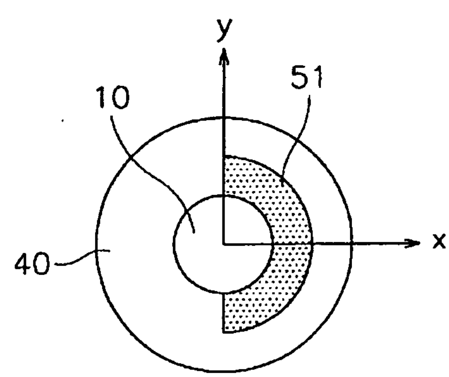


FIG.5A

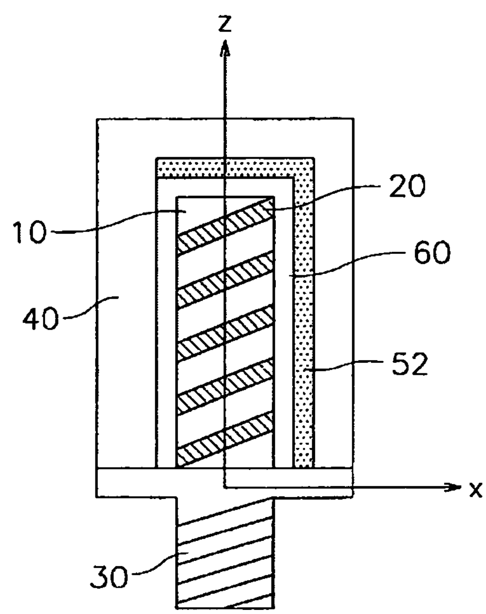



FIG.5B

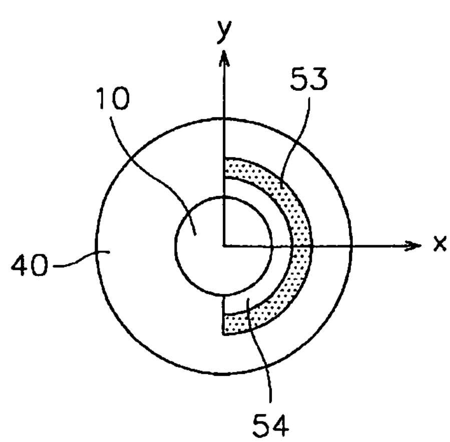


FIG.6A

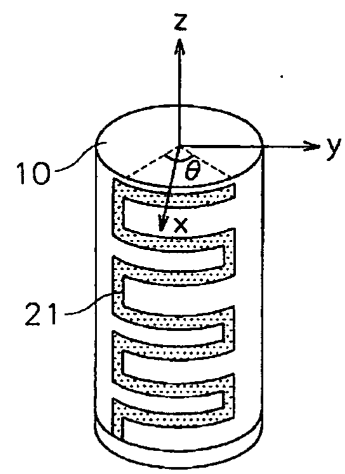



FIG.6B

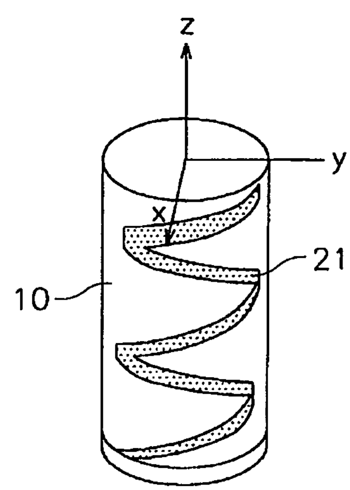


FIG.7

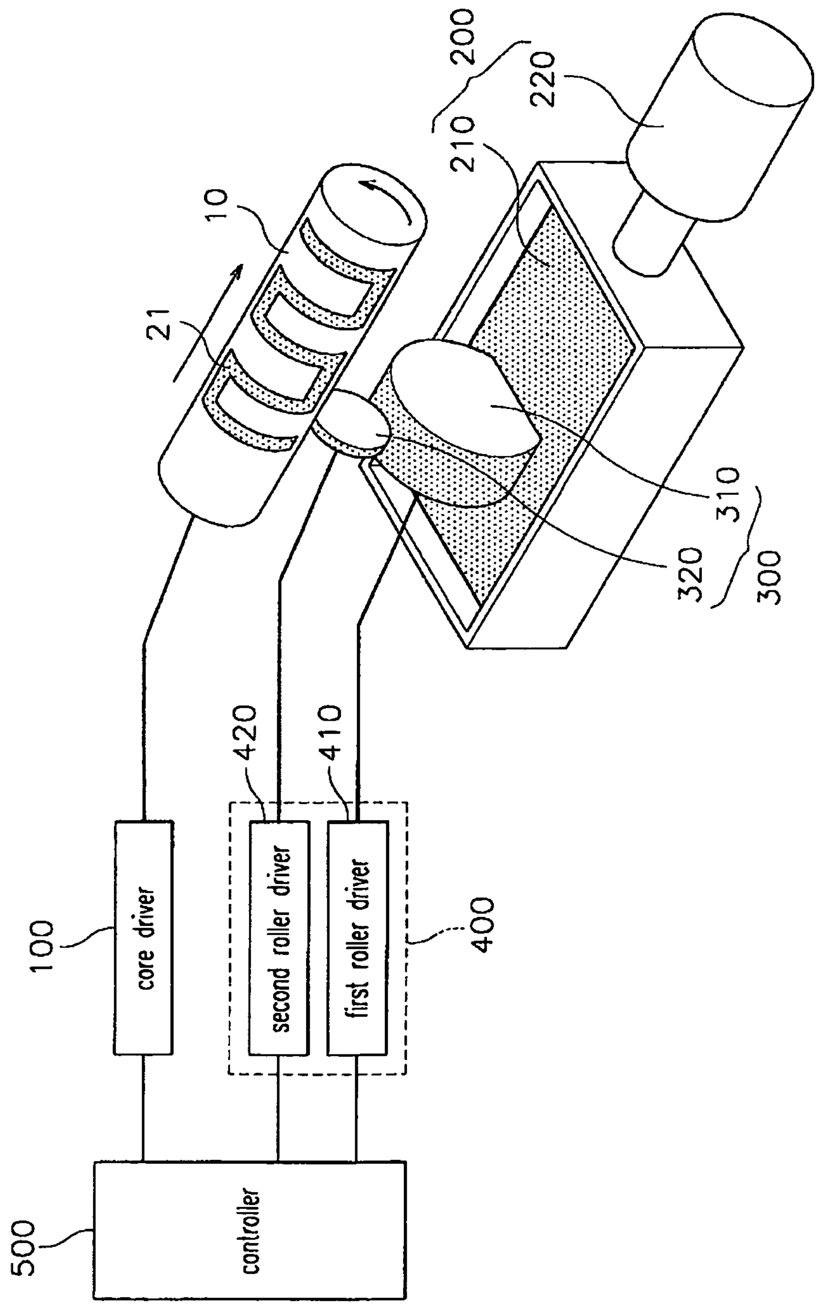

200
220
210
10
21
310
320
300
420
410
100
core driver
second roller driver
first roller driver
400
500
controller

FIG.8A

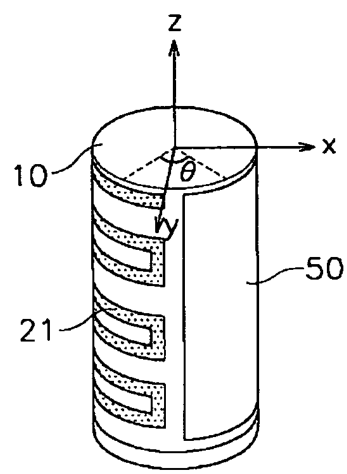



FIG.8B

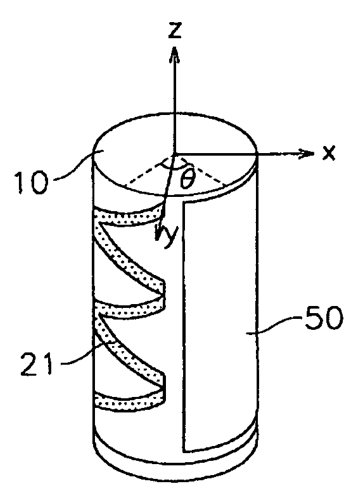


FIG.9A

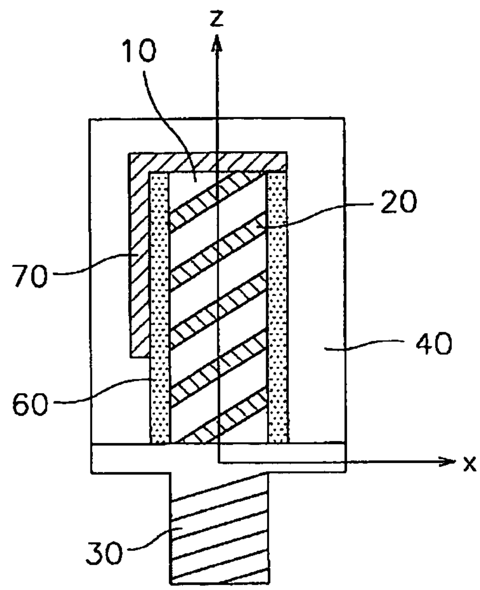



FIG.9B

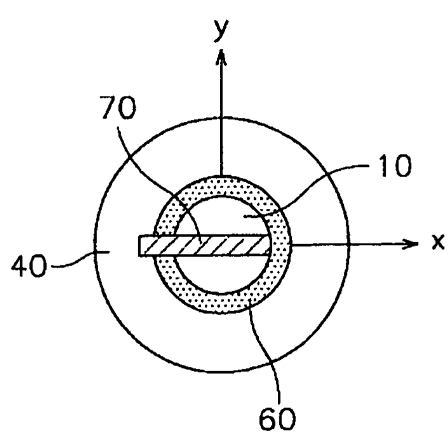


FIG.10

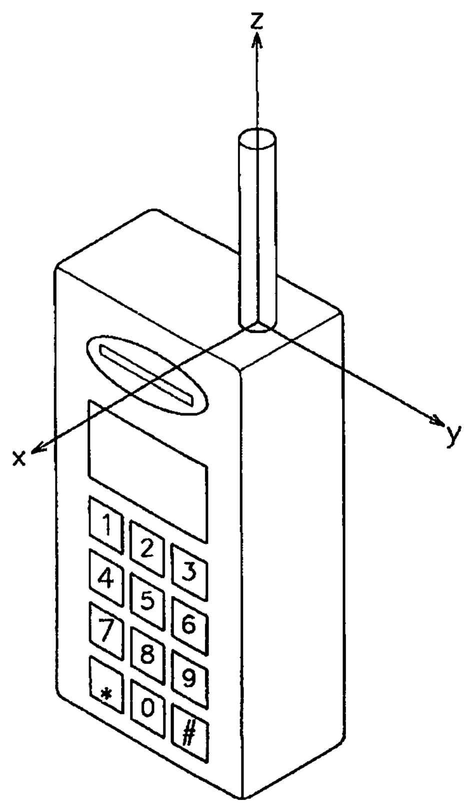
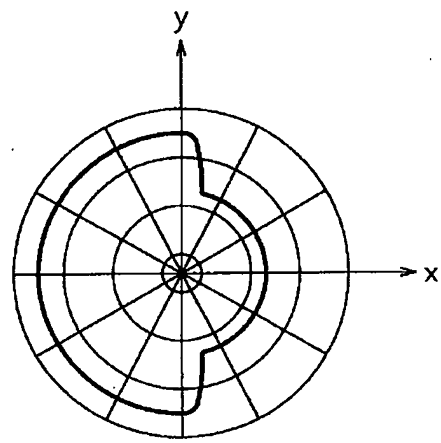
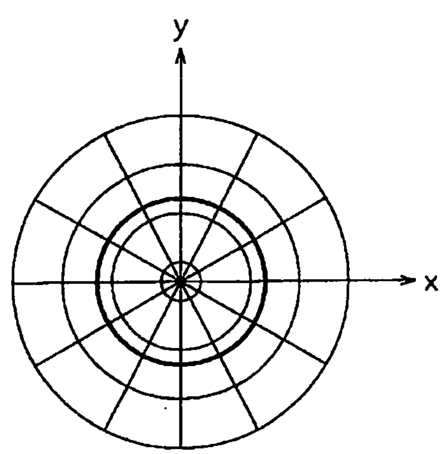


FIG.11A




radiation characteristic in near field

FIG.11B




radiation characteristic in far field

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/KR 00/01526

CLASSIFICATION OF SUBJECT MATTER

IPC$^7$: H01Q 1/36, 1/24, 1/52, 17/00, H04B 1/38, 7/08, H05K 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC$^7$: H01Q, H04B, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | GB 2301228 A (SAMSUNG) 27 November 1996 (27.11.96) the whole document, especially fig. 1, page 4, lines 16-31. | 1-10 |
| A | GB 2336035 A (AUDEN TECHNOLOGY MFG. CO. LTD.) 6 October 1999 (06.10.99) the whole document, especially figs. 1,6,10, page 3, line 6 page 6, line 11. | 1-10 |
| A | US 5353040 A (YAMADA et al.) 4 October 1994 (04.10.94) the whole document, especially abstract, figs. 1,8,14. | 1-10 |
| A | US 5507012 A (LUXON et al.) 9 April 1996 (09.04.96) the whole document, especially figs. 2-4, claims. | 1-10 |
| A | US 5335366 A (DANIELS) 2 August 1994 (02.08.94) the whole document, especially figs. 3,4, abstract. | 1-10 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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„&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 23 March 2001 (23.03.2001) | 12 April 2001 (12.04.2001) |
| Name and mailing adress of the ISA/AT<br>Austrian Patent Office<br>Kohlmarkt 8-10; A-1014 Vienna<br>Facsimile No. 1/53424/535 | Authorized officer<br>HEINICH<br>Telephone No. 1/53424/454 |

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Information on patent family members

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